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ABSTRACT

The purposes of this study were to determine the relationship between item readability and item difficulty in a standardized mathematics achievement test, and to determine if students could raise their mathematics achievement scores if they were given aid in reading items that presented them with reading difficulty. Two hundred third and fourth grade students from metropolitan Denver were selected for the study. It was concluded that the ability to read test items on a mathematics achievement test is a factor in the overall score, and that systematic instruction in some vocabulary words prior to the administration of a test could improve students' scores. The implications of the study are also examined. (RB)

MATHEMATICS ACHIEVEMENT TESTS AND READING

by

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and

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The reliance of mathematics achievement test scores on the examinee's ability to read is becoming quite evident. For example, test M-1 of the Iowa Test of Basic Skills (ITBS) supposedly tests an individual's knowledge of mathematical concepts, yet students must read at least one sentence per item before giving an answer. The last subtest of the ITBS, M-2 or Mathematical Problem Solving, requires the ability to read story problems which can involve three sentences or more. It is the concern of the authors of this report, that if students have poor reading ability, they will have difficulty understanding items which are intended to test mathematical ability; therefore, scores depicting their mathematical ability will be invalid.

Some research has been done in which mathematics test items have been studied for readability. Beardslee and Jerman (1973) found two linguistic variables to be significant predictors of item difficulty. Those variables were: the number of prepositional phrases contained in the question and the number of clauses used. Rosenthal and Resnick (1971) studied the effects of three variables on verbal mathematical problems: (1) problem form, (2) sequence of information and (3) the placement of verbs. They found the first two variables to be significantly related to item difficulty.

Research, then, does support the intuitive indication that a student's inability to do well in a mathematics achievement test might be due to his inability to read the test items. To date little or nothing has been done to determine the increase in mathematical achievement, as measured by a standard achievement test, if students are given aid in reading difficult items. Thus it was the dual purpose of this study to: (1) determine the relationship between item readability and item difficulty in a standardized mathematics achievement test, and (2) determine if students could raise their mathematics achievement scores if they were given aid in reading items

that presented them with reading difficulty.

Method of Study

Two hundred third and fourth grade students from metropolitan Denver were selected for the study. All students attended year-round schools. Students were given subtests M-1 and M-2 of the ITBS in March of 1975. Item difficulties were then calculated for each item. A readability index was also calculated for each item using the formula:

$$\text{item readability} = \frac{\text{number of syllables}}{\text{number of words}}$$

No numerals or symbols were used in the calculation of item readability. The index is sensitive to the increased use of polysyllabic words which has been shown to be a valid and reliable indicator of readability (Fry, 1972).

The Pearson Product Moment Correlation was calculated between item difficulty and item readability for each subtest (M-1 and M-2) and for each grade level (third and fourth). Those correlations are reported in Table 1

Table 1

Correlations between item difficulty and item readability

	Test	r	No. of items
Third grade	M-1	-.39*	30
	M-2	-.10	25
Fourth grade	M-1	-.18	36
	M-2	-.39*	27

* significant at .05 level

A significant negative correlation indicates that the items tended to be more difficult as the item readability increased. In this case a negative

correlation indicates a positive relationship between how difficult an item is to answer and how hard it is to read. This is because the item difficulty index "decreases" as an item becomes more difficult, but the item readability index "increases" as an item becomes harder to read.

As indicated in Table 1, subtest M-1 showed a significant correlation between item difficulty and item readability at the third grade level and subtest M-2 showed a significant correlation at the fourth grade level. The non-significant correlations are not readily explainable. The authors concluded that the two significant correlations justified an attempt to fulfill the second stated purpose of the study.

The most difficult items were selected from each subtest (M-1 and M-2) and for each grade level (third and fourth). The "most difficult" items were operationally defined as those items which 50% or more of the sample answered incorrectly (eg. all items with a difficulty of .50 or less). For each item, 10 students who had missed the item were selected. Each item was typed on a strip of paper using the same format as in the ITBS test booklet. In July of 1975 (five months after the March administration of the test) the selected students for each item were asked to read the item aloud and then answer the item. If students had difficulty reading the item they were aided by the examiner. It is important to note that the examiner did not help the students understand the mathematical concepts presented in the items; the examiner simply made sure the students understood the words in the items. It was the authors' assumption that this procedure was controlling for the reading variable in each item and, thus, making each item a more pure test of mathematics ability.

After the students had responded to the items, item difficulties were calculated. Since only those students who had missed the items in March were selected to be retested, any items they answered correctly were considered a gain in mathematical achievement. In effect, the March item-difficulties for these selected students was .00 on the selected items. The July item difficulties for these students was considerably greater than .00 for all of the selected items. The July mean item difficulty (.42), for selected items and students, was compared (two tailed t-test) with the March item difficulty (.00) for selected items and students and the difference was found to be significant at the .05 level. This was interpreted as an indication that when reading is not a factor in tests of mathematical ability, students' scores will increase, especially the scores of students who have difficulty in reading.

Conclusions and Discussion

While the ITBS subtests M-1 and M-2 purport to measure mathematical achievement, it is evident that the ability to read items is a factor in the overall score. When students were aided in reading items, they were able to answer questions they had previously missed. It is interesting to note that certain words seemed to give a majority of the selected students trouble. Many students could not understand such terms as: rename, sum, missing factor, pint, true sentence, equivalent, whole number, how much and how many more. It would seem that systematic instruction in some vocabulary words prior to the administration of a mathematics achievement test could improve students' scores.

The implications of this study are rather important for teachers as well as for test developers. Many skills are required in reading mathematics

questions. Collier and Redmond (1974) point out that mathematics teachers need to train students to vary their normal reading rate and give their students instruction in technical vocabulary. Critical reading is also required to solve mathematics problems. This might include reading for important details , translating phrases into operations, visualizing concepts and interpreting charts and diagrams. It would seem that teachers of mathematics need to be aware that reading is an important aspect of their content area. Perhaps if some reading instruction were a systematic part of mathematics instruction mathematics achievement test scores would increase.

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